Mapping the literature of clinical laboratory science

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This paper describes a citation analysis of the literature of clinical laboratory science (medical technology), conducted as part of a project of the Nursing and Allied Health Resources Section of the Medical Library Association. Three source journals widely read by those in the field were identified, from which cited references were collected for a three-year period. Analysis of the references showed that journals were the predominant format of literature cited and the majority of the references were from the last eleven years. Applying Bradford's Law of Scattering to the list of journals cited, three zones were created, each producing approximately one third of the cited references. Thirteen journals were in the first zone, eighty-one in the second, and 849 in the third. A similar list of journals cited was created for four specialty areas in the field: chemistry, hematology, immunohematology, and microbiology. In comparing the indexing coverage of the Zone 1 and 2 journals by four major databases, MEDLINE provided the most comprehensive coverage, while the Cumulative Index to Nursing and Allied Health Literature was the only database that provided complete coverage of the three source journals. However, to obtain complete coverage of the field, it is essential to search multiple databases.

INTRODUCTION

This study is part of the ongoing project to map the literature of the allied health professions undertaken by the Nursing and Allied Health Resources Section of the Medical Library Association, first described in 1997 by Schloman [1]. This study focuses on the literature of clinical laboratory science, or medical technology as it is also known. The study's goals are to identify the predominant format of literature used in this field, the currency of the literature most frequently used, the core journals of the field, and the level of indexing coverage of the core journals by the major bibliographic databases. The results will serve as a valuable aid to librarians responsible for collection development in the field and for providing instruction for faculty and students in degree programs. The results will also help practicing members of the profession identify the core literature of their field and the tools through which to access it. Finally, the study will provide guidelines for the producers of bibliographic databases seeking to cover the literature of the field.

HISTORY OF THE CLINICAL LABORATORY SCIENCE PROFESSION

Although rudimentary examinations of human body fluids date back to the time of the ancient Greek physician Hippocrates around 300 BC [2], it was not until 1896 that the first clinical laboratory was opened, a twelve-foot-by-twelve-foot room equipped at a cost of $50 at Johns Hopkins Hospital [3]. At that time, most ''laboratories'' consisted of little more than a corner in physicians' homes, offices, or hospital wards, with physicians performing the procedures themselves. The diagnostic and therapeutic value of laboratory testing was not yet appreciated, and many physicians viewed clinical laboratories simply as an expensive luxury that consumed both valuable space and time [4].

However, the discovery of the causative agents of devastating epidemics such as tuberculosis, diphtheria, and cholera in the 1880s and the subsequent development of tests for their detection in the late 1890s prompted a change in attitude, and by the turn of the century, the laboratory occupied a position of much greater importance. Pathologists began to train assistants, primarily young women, to perform some of the simpler laboratory procedures, freeing the pathologists to pursue advanced aspects of their specialty. In 1922, the American Society of Clinical Pathologists (ASCP) was formed to support the emerging clinical specialty of pathology. In 1926, the American College of Surgeons' accreditation standards decreed that all hospitals have a clinical laboratory under the direction of a physician, preferably a pathologist. This decree had the effect of ensuring that laboratories developed mainly in hospitals under the supervision of physicians [5].

World War I brought about a critical shortage of qualified laboratory assistants to staff the laboratories, prompting the creation of a wide variety of training programs to meet the growing need. In an effort to bring about a degree of standardization to the education of laboratory personnel, ASCP created the Board of Registry (BOR) in 1928 to certify individual laboratory technicians and later the Board of Schools (BOS) for the accreditation of educational programs. Individuals graduating from approved schools and passing the BOR's registry exam were thereafter referred to as ''medical technologists,'' identified by the acronym ''MT (ASCP).'' The parenthetical suffix was added to differentiate these individuals from MTs trained by non-ASCP approved commercial schools. Thus, although created primarily for the physician pathologist, ASCP played a pivotal role in the development of the clinical laboratory science field by establishing standards for both education and competency [6].

However, as the number of medical technologists swelled, they began to desire a greater degree of autonomy and control over the direction of their own profession than was available to them under the rule of ASCP. In 1933, a new organization was formed, the American Society of Clinical Laboratory Technicians (ASCLT), later renamed the American Society of Medical Technologists (ASMT). Although ASMT and ASCP worked closely together for many years, they disagreed over several critical issues, especially the accreditation of schools and certification of technologists, both of which ASCP still controlled. In 1973, as a result of pressure from the U.S. Office of Education and the National Commission on Accrediting, ASCP agreed to disband the BOS and turn over its functions to an independently operated and governed board, the National Accrediting Agency for Clinical Laboratory Sciences (NAACLS) [7]. The issue of independent certification continued to be a source of discord until finally, in 1977, the ASMT withdrew its representatives from the BOR and established the autonomous certification agency, the National Certification Agency for Medical Laboratory Personnel (NCA) [8]. Having achieved independent oversight of both entry into the profession and certification of its member practitioners, clinical laboratory science was at last on its way to achieving the status of an independent profession.

In today's era of rapidly evolving medical research and technology, one can hardly imagine a health care system without the contributions of clinical laboratory scientists. The laboratory analysis of blood and other body fluids plays an essential role in the diagnosis and treatment of disease, as well as in routine preventative medicine. In addition to performing an ever-expanding variety of laboratory analyses, clinical laboratory scientists are active in selecting test methodology and instrumentation, establishing and implementing quality assurance programs, and troubleshooting technological and instrument malfunctions. They hold upper-level management positions in clinical laboratories with responsibility for creating budgets, short- and long-term planning, and supervising laboratory personnel. In teaching institutions, clinical laboratory scientists (CLSs) at the master's and doctoral levels hold faculty positions in NAACLS-approved educational programs.

The educational requirements for clinical laboratory science have evolved in tandem with the development and expansion of the scope of the field. In 1930 when the ASCP issued the first certificates of registration, the requirements consisted of graduation from high school, completion of one year of didactic work, and completion of six months of experience in a recognized laboratory [9]. As the body of knowledge increased in volume and complexity, the educational requirements gradually increased. By 1952, most approved schools required three years of college work, and, ten years later, the BOR formally increased the college prerequisite to three years [10]. During the 1960s, new categories of laboratory workers were created to help cope with the increased workload: the certified laboratory assistant (CLA) with one year of training and the medical laboratory technician (MLT) with two years of training. Simultaneously, specialist categories in chemistry, microbiology, hematology, and blood banking were created. These were followed by the development of master's and doctoral programs to train CLSs for faculty positions at accredited schools. Numerous states currently require licensure of laboratory personnel, with others considering it, thus further ensuring the integrity of the profession.

Owing to the origin of the field in hospital clinical laboratories, the majority of CLSs are still employed in this setting. In rural areas and small community hospitals, they are most likely to be generalists, but, in larger institutions with their wider scope of testing, many CLSs specialize in a specific departments. In recent years, nonhospital opportunities have proliferated in areas such as public health agencies, reference laboratories, forensics, blood and tissue banking, medical research, pharmaceutical companies, veterinary laboratories, industry, sales, marketing, consulting, and software development. However, just as the profession is nearing maturity, a combination of factors is threatening to produce a large-scale shortage of qualified laboratory personnel. In addition to the wide range of opportunities luring CLSs away from the clinical laboratory, additional factors contributing to the shortage include attrition due to persistently low salaries and lack of self-actualization, aging workforce, changing U.S. demographics, and increase in government regulation of clinical laboratories through the Clinical Laboratory Improvement Amendments of 1988 (CLIA '88) [11]. Ironically, the shortage is so critical that ''desperation has led some laboratories to consider hiring individuals without formal laboratory education and providing them with on the job training'' [12].

A review of the literature showed that few bibliometric studies have been conducted for the field of clinical laboratory science. In 1999, Siebers studied the error rate of references in articles published in the *New Zealand Journal of Medical Laboratory Science* [13]. In 1994, Watson and Perrin studied the coverage by the

Cumulative Index to Nursing and Allied Health Literature (CINAHL) and MEDLINE, both on CD-ROM, of the literature in four allied health areas: medical technology, medical records, radiologic technology, and respiratory therapy [14]. In this study, a group of faculty members from these four fields were asked to identify the top five or fewer journals that they felt were ''core'' to their area. From the composite list, fifteen titles could be readily identified as being either from the field of medical technology or general medicine. Comparing these fifteen titles to the results of the present study, ten of them (67%) were included in Zone 1 of this study, four (27%) were in Zone 2, and only one (6%) was in Zone 3. Thus, Watson and Perrin's work provided early qualitative evidence of the core journals of the field, the results of which were expanded upon and quantified by the present study. The Watson and Perrin study also demonstrated the need to search both databases, as they found only a 30% overlap in the titles from the journal survey and a 14% overlap in citation retrieval.

METHODOLOGY

This study employed a common methodology as described by Schloman [15], with minor modifications. The pivotal first step of the study was to identify the ''source'' journals for the field of clinical laboratory science. The highly respected ''Brandon/Hill Selected List of Print Books and Journals in Allied Health'' [16] served as an excellent starting point. In addition to being included on this list, titles selected as source journals were to cover *all* areas of the field, rather than focusing solely on one specialty area. They were to be titles that are currently read by practicing technologists and that are peer reviewed, at least for feature articles. Finally, they were to include articles written by CLSs rather than solely by medical doctors or postgraduate researchers.

Two prominent professional organizations in the field of clinical laboratory science—the American Society for Clinical Laboratory Science (ASCLS), formerly the American Society of Medical Technologists, and the American Society for Clinical Pathology (ASCP)—each produce a high-quality, peer-reviewed journal that meet the above criteria. Selection of an additional source journal proved to be more difficult, prompting the solicitation of opinions from educators from around the country via email in the same manner employed by Stevens [17]. Of twenty email messages sent, nine usable responses were received. Respondents almost overwhelmingly suggested the publications mentioned above as clear candidates for source journals. In addition, they suggested the publications *Medical Laboratory Observer (MLO)* by Nelson Publishing, Nokomis, Florida, and *Advance for Medical Laboratory Professionals* by Merion Publications, King of Prussia, Pennsylvania. Because the latter contains few articles with references and is a biweekly trade magazine for which a full three-year run would be very difficult to obtain, it was not selected. Thus, the source journals selected were *Clinical Laboratory Science* published by ASCLS, *Laboratory Medicine* published by ASCP, and *MLO.* These choices accurately reflected the experience of the author following twenty years' experience in the clinical laboratory science field.

Following identification of the source journals, a database of references cited by each article in the source journals from the years 1998, 1999, and 2000 was constructed using Microsoft® Access. Any article containing references was included, except for editorials, news briefs, letters, and other miscellaneous items. Short question-and-answer and clinical-tips articles were included, because they frequently included disproportionately long lists of references.

Captured database elements included the source journal title, volume, issue, and year of publication; the format of each reference; the year of publication for each reference; and, if the reference was a journal, its title. In addition, because of the tendency toward specialization in the field of clinical laboratory science, each article was categorized into one of the following specialty areas: chemistry, hematology (including coagulation), immunohematology (often referred to as ''blood banking''), microbiology, immunology, molecular biology and diagnostics, urinalysis, professional, or miscellaneous. These additional data would enable a more specific analysis of the journals used by each of the subfields, in addition to the data for the field overall. The first four specialty areas had sufficient numbers of citations to permit further analysis.

Format types included books, journals, government documents, Websites (nongovernmental), and miscellaneous. The books category included certain mainstays of the clinical laboratory such as the *Technical Manual of the American Association of Blood Banks* [18] and *Clinical Diagnosis and Management by Laboratory Methods* [19]. The government documents category included documents published on the Web but excluded periodicals such as *Morbidity and Mortality Weekly Reports (MMWR)* and *FDA Consumer,* which were listed by title in the journal category. The miscellaneous category included documents from governing bodies such as the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and NAACLS, as well as ASCP Board of Registry materials, College of American Pathologists (CAP) Check Samples, manufacturer's package inserts, poster sessions from professional meetings, software, and newspapers.

The completed database was then sorted and analyzed according to various parameters. The distribution of publication formats was determined, both for each source journal individually and for all three as a group, according to the format types described above. The distribution of publication dates of cited references was also analyzed, using the year ranges of pre-1960, 1960 to 1969, 1970 to 1979, 1980 to 1989, 1990 to 1994, 1995 to 1999, and 2000, including ''in-press'' items.

For journals, the number of times each title was cited was also tabulated, enabling the creation of a list of journal titles ranked by descending order of citation frequency. Citations to journals that had experienced

Table 1
Cited format types by source journal and total frequency

Cited format type	Source journal: *Clinical Laboratory Science* No.	%	*Laboratory Medicine* No.	%	*Medical Laboratory Observer (MLO)* No.	%	Totals No.	%
Journal articles	1,904	83.5%	2,471	78.8%	1,083	72.6%	5,458	79.0%
Books	244	10.7%	406	12.9%	216	14.5%	866	12.5%
Government documents	31	1.4%	67	2.1%	58	3.9%	156	2.3%
Miscellaneous	82	3.6%	166	5.3%	90	6.0%	338	4.9%
Websites (nongovernmental)	19	0.8%	27	0.9%	44	3.0%	90	1.3%
Total	2,280	100.0%	3,137	100.0%	1,491	100.0%	6,908	100.0%

title changes were combined under the most recent title, under the assumption that the intellectual content had remained the same. A cursory examination of this list revealed the presence of a few journal titles that accounted for a relatively large proportion of the total number of citations, while the majority of journal titles contributed a much smaller number, often only one or two citations from all three source journals over all three years. In an effort to evaluate this disparity, Bradford's Law of Scattering [20] was applied. This bibliometric principle holds that for any given discipline, a small core group of journals (Zone 1) will produce the largest number of citations; followed by a second, larger group of journals (Zone 2), which will be cited somewhat less frequently; and finally a much larger group of journals (Zone 3), all of which will be cited relatively infrequently. The ranked list of journal titles was thus divided into three approximately equal zones according to the number of citations received, both for the field of clinical laboratory science overall and for each of the four main specialty areas.

Finally, the indexing coverage for the year 2002 for each journal in Zones 1 and 2 by several major bibliographic databases covering the field of clinical laboratory science was analyzed. Four databases were checked: BIOSIS, CINAHL, EMBASE, and MEDLINE. Each journal title in Zones 1 and 2 was checked against each database list of journals indexed, with selective indexing noted whenever that information was provided.

RESULTS

A total of 532 articles from the years 1998, 1999, and 2000 were analyzed. The total number of references cited by these articles was 6,908. The first source journal, *Clinical Laboratory Science,* contributed 2,280 citations for 33.0% of the overall total. It contained 121 articles with references in the three-year period, for an average of nineteen citations per article. The second source journal, *Laboratory Medicine,* contributed 3,137 citations for 45.4% of the overall total. There were 229 articles in the three-year period, for an average of fourteen citations per article. Finally, *MLO* contributed 1,491 citations for 21.6% of the overall total. There were 182 articles, with an average of eight citations per article in that journal.

Table 1 provides a breakdown of the number of references from journal articles, books, government documents, miscellaneous sources, and nongovernmental Websites, both overall and by source journal. Journal articles clearly represented the overwhelming majority of cited references, with a total of 79.0% overall. Books placed a distant second at 12.5%. Only a small degree of variation in the formats cited existed among the three source journals. *Clinical Laboratory Science* made heaviest use of journal articles, while *MLO* made greatest use of nongovernmental Websites and book literature.

The currency of the literature cited is summarized in Table 2. Not surprisingly, nearly 75.0% of the cita-

Table 2
Cited format types by publication year periods

Publication year (range)	Cited format type: Journal articles No.	%	Books No.	%	Government documents No.	%	Miscellaneous No.	%	Websites (nongovernmental) No.	%	All formats No.	%
2000 (including "in press")	40	0.7%	10	1.2%	5	3.2%	11	3.3%	14	15.6%	80	1.2%
1995–1999	2,544	46.6%	392	45.3%	83	53.2%	207	61.3%	65	72.2%	3,291	47.6%
1990–1994	1,434	26.3%	251	29.0%	36	23.1%	64	18.9%	1	1.1%	1,786	25.9%
1980–1989	888	16.3%	151	17.4%	11	7.0%	20	5.9%	2	2.2%	1,072	15.5%
1970–1979	300	5.5%	33	3.8%	2	1.3%	14	4.1%	0	—	349	5.0%
1960–1969	133	2.4%	13	1.5%	1	0.6%	0	—	0	—	147	2.1%
Pre-1960	119	2.2%	14	1.6%	2	1.3%	2	0.6%	0	—	137	2.0%
Unknown	0	—	2	0.2%	16	10.3%	20	5.9%	8	8.9%	46	0.7%
Total	5,458	100.0%	866	100.0%	156	100.0%	338	100.0%	90	100.0%	6,908	100.0%

Table 3
Distribution by zone of cited journals and references

	Cited journals		Cited journal references		
Zone	No.	%	No.	%	Cumulative total
1	13	1.4%	1,846	33.8%	1,846
2	81	8.6%	1,847	33.8%	3,694
3	849	90.0%	1,765	32.4%	5,458
Total	943	100.0%	5,458	100.0%	

tions overall date from the previous decade or later (i.e., 1990–2000), and over 90.0% of them date from the previous two decades (i.e., 1980–2000). Figures for journal articles and books generally coincide with the overall figures. Government documents and miscellaneous sources tend to be somewhat more current than other items, perhaps reflecting a shorter publication cycle. The Websites are understandably very current, dating predominantly from the last six years, with the majority from 1998 and later.

A total of 943 journal titles were cited, yielding a total of 5,458 citations. In applying Bradford's Law of Scattering, three approximately equal zones were created, as shown in Table 3. The first zone required only thirteen journals (1.4%) to produce slightly more than one third of the citations. This group of very productive journals comprised the ''core'' journal literature for the field of clinical laboratory science. In contrast, the second zone required more than six times that number, eighty-one journals (8.6%), to achieve the second third of the citations. Finally, the remaining 90% of the journal titles, 849 in number, were required to make up the remaining one third of journal article citations.

The list of journals comprising Zones 1 and 2 is shown in Table 4, along with the total number of citations each title received. The thirteen journals in Zone 1 include all three source journals, each of whose primary audience is members of the clinical laboratory science profession. Zone 1 also includes general medicine journals such as *JAMA, New England Journal of Medicine,* and *The Lancet.* Most importantly, the Zone 1 listing indicates the presence of several well-defined specialty areas in the profession, with the inclusion of titles such as *Clinical Chemistry, Blood, MMWR,* and *Transfusion.*

Table 5, which lists the Zone 1 journals for each of four specialty areas of clinical laboratory science, illustrates the pronounced difference between the main specialty areas. Although these four areas contribute at least one journal each to the overall list in Table 4, the specialty area lists contain unique titles, except for two duplicates, *New England Journal of Medicine* and *American Journal of Clinical Pathology,* each of which appears in only two areas.

Indexing coverage for the year 2002 for each journal in Zones 1 and 2 by four major bibliographic databases is also shown in Table 4, with Table 6 providing further analysis. MEDLINE clearly provides the most complete coverage. It indexes 92.3% of the Zone 1 titles and 93.8% of the Zone 2 titles. BIOSIS and EMBASE each index 76.9% of the Zone 1 journals and 81.5% and 87.7% of the Zone 2 journals, respectively. In contrast, CINAHL, indexes 69.2% of the Zone 1 titles and 30.9% of the Zone 2 titles. However, CINAHL is the only one of the four databases to index 100% of the source journals. MEDLINE indexes two of the source journals, EMBASE indexes one, and BIOSIS does not index any of them. None of the source journals are indexed by more than two of the databases.

DISCUSSION

As one would expect, the most heavily referenced format of literature is the journal article, far outdistancing all other format types. If not for the frequent references to a small number of heavily used technical and procedural textbooks in the clinical laboratory, this number would be even higher. With the rapid increase in use of the Web as a means of information transfer, that format will no doubt gain in prominence in the coming years. The age distribution of the cited references is quite current, with the bulk of them falling in the most recent five-year range.

One of the most valuable pieces of information to come out of this study is the identification of the core journals, both for the field of clinical laboratory science overall and for the four specialty areas. The number of journals contained in Zone 1 is larger than for most of the other allied health professions studied in this project, perhaps because of the wide scope of the field. From the list of Zone 1 and 2 journals for the overall profession (Table 4), it is apparent that the literature of clinical laboratory science draws heavily from the sciences upon which it is based. Zone 1 for the overall profession contains titles that span the breadth of the profession, including chemistry, hematology, immunohematology, and microbiology, thus serving the needs of the generalist CLS. In contrast, the titles in Zone 1 for the four specialty areas (Table 5) identify a completely different core body of literature unique to those aspects of the profession and of primary interest to the specialist CLS.

In examining the coverage of the literature of this profession, it is apparent that each indexing database fills a valuable niche and together they provide complete coverage of the field. The comprehensive ''super'' biomedical databases, EMBASE and MEDLINE, perform very well overall but suffer from the significant shortcoming of failing to index all of the source journals, which are probably the publications most heavily read by members of the profession. In contrast, CINAHL's 100% coverage of the three source journals makes it an essential database for this field, despite its relatively small size and narrow focus. Finally, BIOSIS capably fills the gap that exists between the strictly clinical literature and the preclinical sciences literature. The study demonstrates that, to cover the field comprehensively, it is essential to search multiple bibliographic databases.

Table 4
Distribution and indexing coverage in 2002 of cited journals in Zones 1 and 2

Cited journal	No. of cites	BIOSIS	Cumulative Index to Nursing and Allied Health Literature (CINAHL)	EMBASE	MEDLINE
Zone 1					
1 Am J Clin Pathol	231	Y	N	Y	Y
2 Clin Chem	205	Y	N	Y	Y
3 Clin Lab Sci	191	N	Y	N	Y†
4 Lab Med	182	N	Y	Y	N
5 JAMA	158	Y	Y†	Y	Y
6 N Engl J Med	152	Y	Y†	Y	Y
7 Blood	131	Y	N	Y	Y
8 J Clin Microbiol	126	Y	N	Y	Y
9 Arch Pathol Lab Med	109	Y	Y†	Y	Y
10 Med Lab Obs (MLO)	94	N	Y	N	Y
11 Morb Mortal Wkly Rep (MMWR)	93	Y	Y†	N	Y
12 Lancet	92	Y	Y†	Y	Y
13 Transfusion (Bethesda)	82	Y	Y†	Y	Y
Zone 2					
14 Ann Intern Med	80	Y	Y†	Y	Y
15 Thromb Haemost	66	Y*	N	Y	Y
16 Acta Cytol	63	Y	N	Y	Y
17 Science	58	Y	N	Y	Y†
18 Br J Haematol	56	Y	N	Y	Y
19 Am J Med	52	Y	N	Y	Y
20 Arch Intern Med	51	Y	Y†	Y	Y
21 Clin Infect Dis	51	Y	N	Y	Y
22 J Infect Dis	44	Y*	Y†	Y	Y
23 Am J Hematol	42	Y	N	Y	Y
24 Clin Leadersh Manag Rev	37	N	Y	N	Y
25 Nature	36	Y	N	Y	Y†
26 J Urol	33	Y	N	Y	Y
27 Am J Obstet Gynecol	31	Y	Y†	Y	Y
28 Thromb Res	31	Y*	N	Y	Y
29 Circulation	30	Y	Y†	Y	Y
30 Cancer	29	Y	N	Y	Y
31 J Clin Pathol	29	Y	N	Y	Y
32 Semin Hematol	29	Y	N	Y	Y
33 J Pediatr	28	Y*	Y†	Y	Y
34 Ann Emerg Med	27	N	Y	Y	Y
35 BMJ	27	Y	Y†	Y	Y
36 J Forensic Sci	27	Y	N	Y	Y†
37 Diabetes Care	25	N	Y†	Y	Y
38 Proc Natl Acad Sci U S A	25	Y*	N	Y	Y†
39 J Immunol	23	N	N	Y	Y
40 Semin Thromb Hemost	23	Y*	N	Y	Y
41 Alcohol Clin Exp Res	22	Y*	N	Y	Y
42 Lab World‡	22	N	N	N	N
43 Clin Chim Acta	21	Y*	N	Y	Y
44 Obstet Gynecol	21	Y	Y†	Y	Y
45 CAP Today	20	N	N	N	Y
46 Gastroenterology	20	Y	N	Y	Y
47 J Clin Invest	20	Y*	N	Y	Y
48 Advance Med Lab Profs	19	N	N	N	N
49 J Biol Chem	19	Y*	N	Y	Y
50 J Lab Clin Med	19	Y	Y†	N	Y
51 Pediatrics	19	Y	Y†	Y	Y
52 Clin Lab Haematol	18	N	N	N	Y
53 Clin Lab Med	18	N	Y†	N	Y
54 Clin Microbiol Rev	18	Y	N	Y	Y
55 Crit Care Med	18	N	Y†	Y	Y
56 J Anal Toxicol	18	N	N	Y	Y
57 J Toxicol Clin Toxicol	18	Y*	N	Y	Y
58 Am J Respir Crit Care Med	17	Y*	Y†	Y	Y
59 Am J Cardiol	16	Y	Y†	Y	Y
60 Clin Lab News	16	N	N	N	N
61 Clin Microbiol Newslett	16	Y	N	Y	N
62 Hematol Oncol Clin North Am	16	Y*	Y†	Y	Y
63 Leukemia	16	Y	N	Y	Y
64 Cytometry (including supplement)	15	Y*	N	Y	Y
65 Mayo Clin Proc	15	Y	Y†	Y	Y
66 Vox Sang	15	Y*	N	Y	Y
67 Chest	14	Y	Y†	Y	Y
68 Hepatology	14	Y	N	Y	Y
69 Am J Gastroenterol	13	Y*	N	Y	Y
70 Arterioscler Thromb Vasc Biol	13	Y	N	Y	Y

Table 4
Continued

Cited journal	No. of cites	BIOSIS	Cumulative Index to Nursing and Allied Health Literature (CINAHL)	EMBASE	MEDLINE
71 Clin Biochem	13	Y	N	Y	Y
72 Diagn Cytopathol	13	Y	N	Y	Y
73 Emerg Infect Dis	13	Y	N	Y	Y
74 Surgery	13	Y	N	Y	Y
75 Cell	12	Y*	N	Y	Y
76 Clin Hemost Rev	12	N	N	N	N
77 Diabetes	12	Y*	Y†	Y	Y
78 Kidney Int (including supplement)	12	Y*	N	Y	Y
79 Med Clin North Am	12	Y*	Y†	Y	Y
80 Antimicrob Agents Chemother	11	Y	N	Y	Y
81 Clin Chem Lab Med	11	Y	N	Y	Y
82 Int J Syst Evol Microbiol	11	Y*	N	Y	Y
83 J Am Coll Cardiol	11	N	Y†	Y	Y
84 J Intern Med (including supplement)	11	Y	N	Y	Y
85 Urology	11	Y	N	Y	Y
86 Ann Hematol	10	Y*	N	Y	Y
87 Cancer Res	10	Y*	N	Y	Y
88 Epidemiol Infect	10	Y*	N	Y	Y
89 Eur J Haematol	10	Y*	N	Y	Y
90 Gut	10	Y	N	Y	Y
91 J Acquir Immune Defic Syndr	10	Y	N	Y	Y
92 J Allied Health	10	N	Y	N	Y
93 J Clin Oncol	10	Y	Y†	Y	Y
94 South Med J	10	Y	N	Y	Y

* = Indexed "cover-to-cover" in BIOSIS.
† = Selectivity indexed (CINAHL and MEDLINE).
‡ = Ceased publication in 1982.

CONCLUSION

Librarians providing reference assistance to students, faculty, and practicing members of the clinical laboratory science profession should focus primarily on the recent journal literature, using book literature, government documents, and miscellaneous materials when appropriate. An understanding of the structure of the field is tremendously helpful in providing reference assistance, especially for the specialist CLS. The lists of Zone 1 and 2 journals from this study, both for the field overall and the four featured specialty areas, are of great value to librarians responsible for collection development and instruction. Comprehensive coverage of the literature of the field can only be accomplished through the use of multiple bibliographic databases, although each of the various indexing services fills an important niche.

Table 5
Zone 1 journals within four specialty areas of clinical laboratory science

Specialty area	Zone 1 journals*
Clinical chemistry	Clin Chem JAMA N Engl J Med Am J Clin Pathol Circulation Ann Emerg Med Diabetes Care J Urol Arch Intern Med J Toxicol Clin Toxicol Lancet
Clinical hematology	Am J Clin Pathol Blood Thromb Haemost Am J Hematol Arch Pathol Lab Med Br J Haematol
Clinical microbiology	J Clin Microbiol MMWR Clin Infect Dis J Infect Dis
Clinical immunohematology	Transfusion N Engl J Med Br J Haematology

* Listed in descending order of citation frequency.

An awareness of the Zone 1 and 2 journals for the field and the indexing services covering them is vital to practicing technologists as well. With information literacy becoming increasingly important in health care, it is imperative that the professional be aware of the full range of tools with which to access the current literature. The ability to select the appropriate bibliographic database for the particular information need is a valuable first step to using the literature.

Attempting to cover a field whose literature spans topics ranging from highly specialized clinical skills to cutting-edge molecular diagnostic techniques still confined to the research laboratory is bound to be a challenge for any indexing service. Because the field is so broad in scope, no one database can claim to cover it comprehensively, but rather their different strengths serve to complement one other. At a minimum, database producers should provide coverage of all three source journals, with the major biomedical databases covering them comprehensively. In addition, they

Table 6
Indexing coverage of source journals and journals in Zones 1 and 2

Zone	Coverage	BIOSIS	CINAHL	EMBASE	MEDLINE
Source journals	Indexed	0	3 (100.0%)	1 (33.3%)	2 (66.7%)
(n = 3)	Not indexed	3 (100.0%)	0	2 (66.7%)	1 (33.3%)
Journals in Zone	Indexed	10 (76.9%)	9 (69.2%)	10 (76.9%)	12 (92.3%)
1 (n = 13)*	Not indexed	3 (23.1%)	4 (30.8%)	3 (23.1%)	1 (7.7%)
Journals in Zone	Indexed	66 (81.5%)	25 (30.9%)	71 (87.7%)	76 (93.8%)
2 (n = 81)	Not indexed	15 (18.5%)	56 (69.1%)	10 (12.3%)	5 (6.2%)

* Includes source journals.

should be encouraged to pick up indexing coverage of those publications in Zones 1 and 2 that are not currently covered by any one of the four databases.

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REFERENCES

1. SCHLOMAN BF. Mapping the literature of allied health: project overview. Bull Med Libr Assoc 1997 Jul;85(3):271–7.
2. BERGER D. A brief history of medical diagnosis and the birth of the clinical laboratory. part 1: ancient times through the 19th century. Med Lab Obs 1999 Jul;31(7):28–30,32,34–40.
3. LINDBERG DS, BRITT MS, FISHER FW. Williams' introduction to the profession of medical technology. 4th ed. Philadelphia, PA: Lea & Febiger, 1984.
4. KOTLARZ VR. Tracing our roots: origins of clinical laboratory science. Clin Lab Sci 1998 Jan/Feb;11(1):5–7.
5. IBID., 7.
6. KOTLARZ VR. Tracing our roots: the beginnings of a profession. Clin Lab Sci 1998 May/Jun;11(3):161–6.
7. KOTLARZ VR. Tracing our roots: years of turmoil (1962–1977). Clin Lab Sci 1999 Nov/Dec;12(6):336–41.
8. IBID., 340.
9. KOTLARZ VR. Tracing our roots: the broadening horizons of clinical laboratory practice (1945–1962). Clin Lab Sci 1998 Nov/Dec;11(6):339–45.
10. IBID., 343.
11. KOTLARZ VR. Tracing our roots: new opportunities and new challenges in clinical laboratory science (1977–1992). Clin Lab Sci 2001 Winter;14(1):13–8.
12. MASS D. The manpower shortage: what next? Lab Med 2002 Jul;33(7):505–10.
13. SIEBERS R. Accuracy of references in the New Zealand Journal of Medical Laboratory Science. New Zeal J Med Lab Sci 1999 Aug;53(2):46,48.
14. WATSON MM, PERRIN R. A comparison of CINAHL and MEDLINE CD-ROM in four allied health areas. Bull Med Libr Assoc 1994 Apr;82(2):214–6.
15. SCHLOMAN, op. cit.
16. HILL DR, STICKELL HN. Brandon/Hill selected list of print books and journals in allied health. Bull Med Libr Assoc 2000 Jul;88(3):218–33.
17. STEVENS SR. Mapping the literature of cytotechnology. Bull Med Libr Assoc 2000 Apr;88(2):172–7.
18. BRECHER M, ED. Technical manual of the American Association of Blood Banks. 13th ed. Bethesda, MD: American Association of Blood Banks, 1999.
19. HENRY JB, ED. Clinical diagnosis and management by laboratory methods. 20th ed. Philadelphia: W. B. Saunders, 2001.
20. BRADFORD SC. Documentation. London, U.K.: Crosby, Lockwood, 1948.

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